MicroFab Technote 99-03
Drive Waveform Effects on Ink-Jet Device Performance

Pulse Width Effects

A piezoelectric demand mode ink-jet device can be driven by a simple “On-Off” pulse that moves the piezoelectric transducer and then returns it to the rest state. Given finite rise and fall times, the waveform become trapezoidal, as shown in Figure 1.

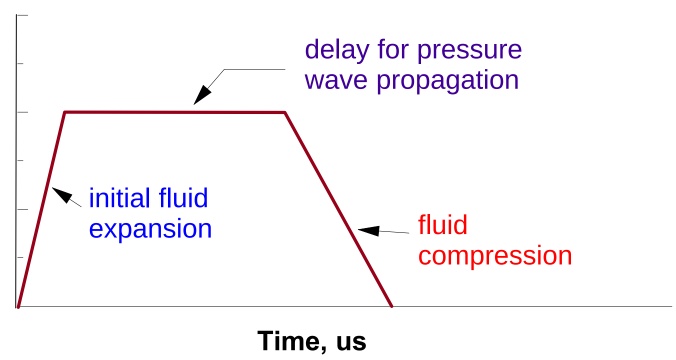

Figure 1

All demand mode ink-jet devices have fluid acoustic resonances due to compressibility effects. This implies the existence of an optimum pulse width, which is a well known phenomenon associated with drop-on-demand devices.[1,2,3] Optimum is defined as achieving the highest drop velocity and/or mass for a given amplitude pulse. The optimum pulse width is more distinct if the piezoelectric transducer is driven so that a negative pressure is created in the fluid initially, and the return to rest state creates a pressure rise, as is indicated in Figure 1.

To illustrate pulse width effects, a demand mode device with an orifice diameter of 71 microns was operated with butyl carbitol (5.3cp, 30 dy/cm) at 2kHz and 67 volts. The drop velocity and volume were measured as a function of pulse width. Pulse width was varied by changing the dwell time while leaving the rise and fall times as 7 and 12.5 microseconds, respectively. These results are shown in Figure 2. Note that the drop velocity decreases continuously to zero, whereas the drop volume drops suddenly to zero. This is a consequence of the restraining forces (viscous and surface tension) on the drop.

Pulse Amplitude Effects

The effects of pulse amplitude were examined using the same device, fluid, and pulse frequency. Figure 3 shows the experimental results. The same volume threshold as is seen in the pulse width results occurs for amplitude variation, and drop volume is linear with drive voltage. Drop velocity become linear after drop velocity is greater than 2 m/s. This non-linearity is also due the viscous and surface tension restraining forces on a drop.

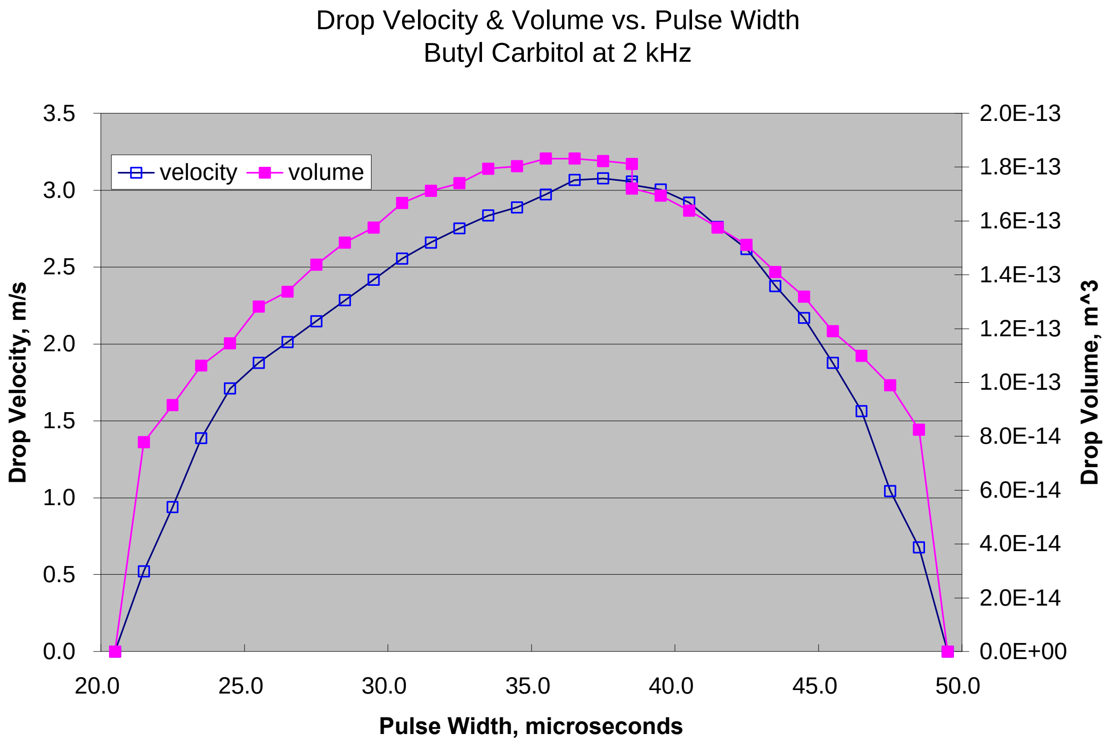

Figure 2

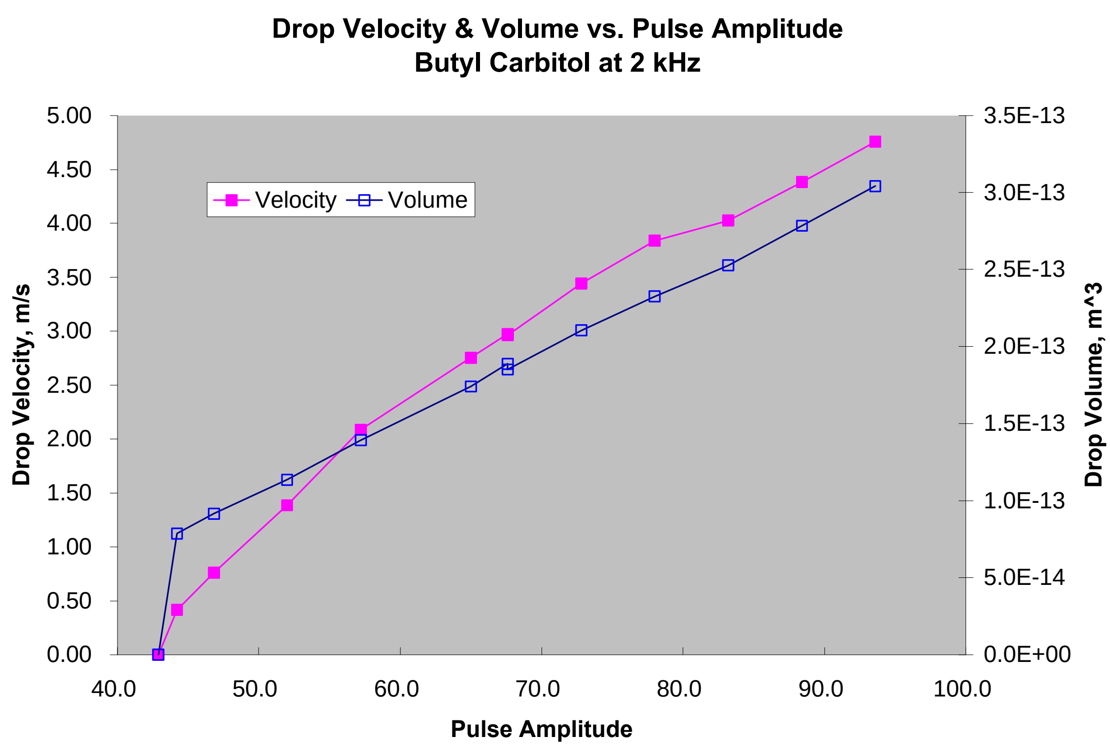

Figure 3

Complex Waveform Effects

The simple waveform shown in Figure 1 can be extended to become a bipolar pulse, as shown in Figure 4. The function of the initial portion of the waveform remains the same. The second part of the waveform can be used to cancel some of the residual acoustic oscillations that remain in the device after drop ejection. For the case when the piezoelectric transducer is centered of the acoustic cavity, the optimum bipolar waveform has the positive and negative going amplitudes are equal, and the second dwell time is twice the initial dwell time.

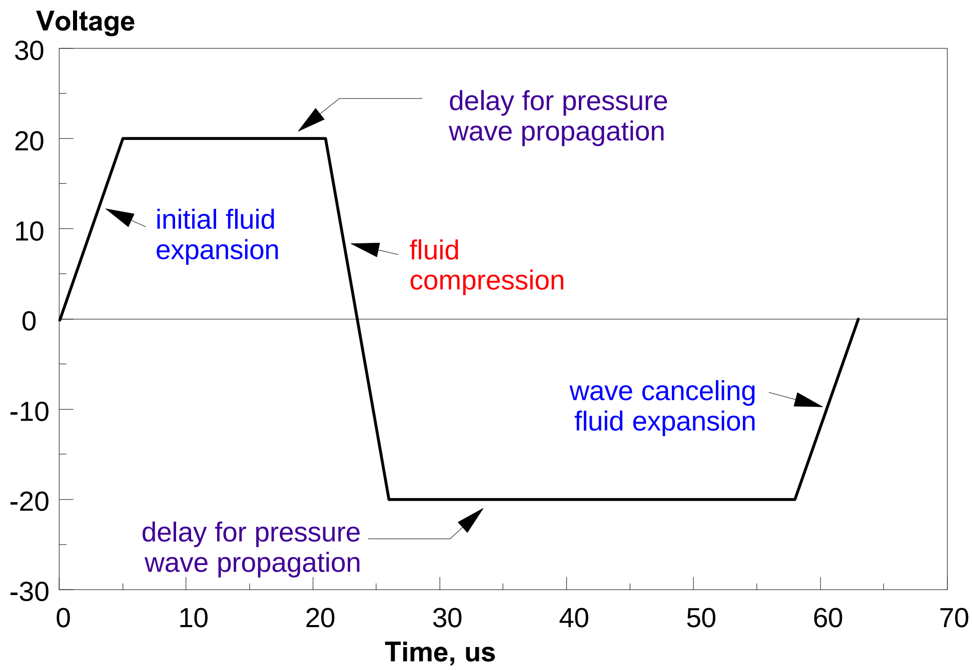

Figure 4

References

1. D.B. Bogy and F.E. Talke, "Experimental and Theoretical Study of Wave Propagation Phenomena in Drop-On-Demand Ink Jet Devices," *IBM Journ. Res. Develop.,* Vol. 29, pp. 314-321, 1984.
2. J.F. Dijksman, "Hydrodynamics of Small Tubular Pumps," *Journ. Fluid Mech.,* Vol. 139, pp. 173-191, 1984.
3. D.B. Wallace, "A Method of Characteristics Model of a Drop-On-Demand Ink-Jet Device Using an Integral Method Drop Formation Model," ASME publication 89-WA/FE-4, December 1989.